THE HISTORY AND DEVELOPMENT OF STREET LIGHTING SYSTEMS IN THE SUBURBS OF WASHINGTON

presented to

THE TAU BETA PI HONORARY ENGINEERING FRATERNITY
UNIVERSITY OF MARYLAND

by

William A. Harmon, '35

January 12, 1934.

S U M M A R Y

Street lighting was desired in the suburbs of Washington as a protection to life and property, as a boost to civic pride and publicity, as an aid to the merchants, and finally as a method of facilitating traffic at night.

In the days before the suburban towns had street lighting systems, it was a general practice of the residents to run a line from their houses out to a lamp hung over the front gate. Then in 1908 Chevy Chase is found to have a street lighting system of 58 multiple lamps. In 1912 Takoma Park had a series system of 111 lamps. In 1913 Hyattsville, along with Mt. Rainier, followed with series street lighting. Electrical power was purchased under individual contracts from the Potomac Electric Power Company. New contracts were issued in 1921 to all the suburban towns.

The development in street lighting is marked by an increase in illumination, the number of lamps and the candle power of each lamp. Together with this, there has been a steady improvement in reflecting and refracting devices as well as in the character of the lamp fixtures and diffusing glassware. All of these factors have led to a better distribution of light and consequently a more efficient street lighting system. The series system has replaced the multiple system almost entirely.

The growth of street lighting systems has been necessarily slow in the suburbs due to the comparatively limited town treasuries, but it has been a steady march in the right direction - that is, toward perfection in street lighting.

PURPOSE OF STREET LIGHTING

From the first, street lighting systems were desired as a protection to life and property. Tests were actually conducted to show that lighted streets were of real value in preventing and detecting crime. The people began to have more confidence in venturing out on the streets at night, and hand in hand with that confidence came the growth of the community. Good street lighting was a great boost to the suburbs of Washington. It instilled a feeling of civic pride among the residents and gave the community good publicity. Then, too, it was an aid to merchants. The merchant's prime aim being to sell merchandise, he could set forth attention-getting and interest-compelling window displays for the people on the sidewalks. But how was he to be sure that there would be people on the sidewalks in the vicinity of his store unless there was an adequate street lighting system to attract them?

With the coming of the automobile in great numbers, running at speeds far in excess of the old horse-drawn vehicle of earlier days, the value of good street lighting in the facilitation of traffic became more evident. In the

suburbs the intensity of traffic was not nearly as great as in the city. Nevertheless, it became necessary to have street illumination of sufficiently high order to enable the driver of the automobile to see objects on the road and act before disaster overtook him. It was proved that in 1920, 18% of all deaths at night due to traffic accidents could have been eliminated if adequate street lighting had been available. People began to realize that they were paying considerably more money as a result of accidents and deaths in traffic than they were in attempting to reduce these losses. It was natural that a steady growth in street lighting should follow.

HISTORICAL

In the early days, when people in the suburbs of Washington had just received electric lighting in their homes but had no street lighting system, it was the general practice to string a wire from their houses out to an electric light hung over their front gates. The gas light was very seldom seen in the suburbs, the development in illumination being directly from the kerosene lamp to the electric light in most instances.

The general system used in lighting the homes by electricity was of the multiple type. When the first street lighting systems were installed in the suburbs it was only

natural that they would be multiple. It was the more familiar system and probably the best for street lighting on a small scale as it then was. Thus in 1908 Chevy Chase had fifty-eight multiple lamps. In the next year or two the other suburbs installed simple multiple systems - at least to illuminate the main business street. The first series lights started in Somerset in 1911. Then in 1912 Takoma Park stepped ahead with a new series system of one hundred eleven lamps. Hyattsville followed shortly afterward in 1913 along with Mt. Rainier.

Each of these suburban towns bought electricity from the Potomac Electric Power Company of Washington, D. C. under individual contracts. Each contract was made under varying circumstances and consequently the conditions of each contract were slightly different. Naturally, some dissatisfaction arose from the towns whose people thought they were not getting as fair a deal as some other town. Finally in 1921 the Potomac Electric Power Company, in an effort to standardize conditions, came to an agreement with the suburbs as a whole, revoked the old contracts and gave them all new contracts which were more uniform and which are still in effect. At present the series system has almost entirely replaced the multiple system, although there still remains a small section of Chevy Chase illuminated by the multiple lamps.

REQUIREMENTS OF SUBURBAN LIGHTING

Suburban streets may be divided roughly into two classes: residential streets and business streets. The requirements for an ideal lighting system of a residential street in the suburbs are: (1) adequate lighting so that pedestrians and householders may have a feeling of security; (2) there should be no dark pockets on the streets, lawns, or between the houses; (3) one should be able to recognize road obstructions, transverse and parallel traffic, turns, dead ends, steep grades, railroad tracks, etc.; (4) considerable care must be taken to avoid objectionable light on the houses; (5) the type of fixture used should be in keeping with the character of the neighborhood. The requirments for an ideal suburban business street are: (1) a moderately high level of illumination to increase business, and to prevent accidents and crime; (2) quality with regard to color diffusion of light and freedom from glare; (3) a distribution so controlled as to give sufficient illumination on the street surface, and at the same time allow enough light to strike the buildings and make visible the architectural details; (4) units of such a character as to present an attractive appearance both by day and night, to harmonize with the character of the building, and to carry out the traditions of the town.

The development of street lighting in the suburbs of Washington has ever been to fulfill the above requirements and to some day reach the ideal in street lighting. From the early days there has been a steady increase in illumination by gradually having more lamps and more candle-power per lamp. Along with this is an improvement in reflecting and refracting devices as well as in the character of the lamp fixtures and diffusing glassware. The principles of street lighting systems, however, are essentially the same as they were when the systems were first installed in the suburbs.

STREET LIGHTING SYSTEMS

There are only two general types of street lighting systems; namely, the multiple and the series systems.

MULTIPLE SYSTEM

The earlier type of street lighting introduced in the suburbs was the multiple system. It is the system with which the average layman is more familiar. It is the type of wiring prevalent in our homes, stores, factories, etc. Since a number of lamps are in a parallel arrangement, the total current in the circuit is the sum of the current passing through each lamp. Any one lamp may burn out without affecting any other in the system. It is important

that the proper voltage is impressed upon all the lamps; otherwise they may fall below the rated life output. It is necessary to have heavy wire, comparatively short lines, or extra feeders in order to cut down the voltage drop along the line. Sometimes it is necessary to put a booster or regulator near the end of the line.

When burned, the filament of any lamp gradually vaporizes and the filament vapor deposit on the surface of the bulb causes blackening. This vaporization causes the diameter of the filament to decrease, thus increasing the resistance and decreasing the current. The light output, then, of a multiple lamp decreases throughout life due to two related factors - bulb blackening and decrease in light output of the filament.

In the early days there was a so-called "radial feeder" system for lighting multiple street lamps. Under this scheme a power transformer would serve a locality or group of houses and would be isolated from the others. Then when anything went wrong, the whole locality was in darkness. Also, the further from a transformer a house was located the lower the voltage and the lower the light output from the lamp.

Under the more recent "network" idea, all transformers of an AC system and the branch currents of a DC

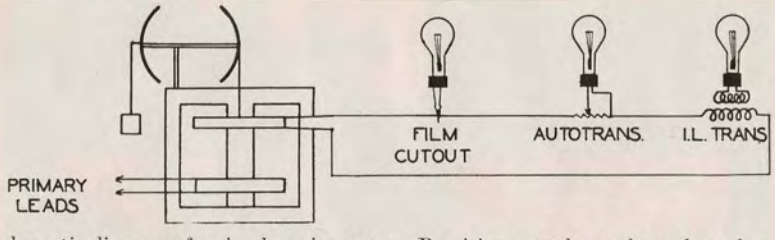
system are tied together in such a way that an ordinary failure does not materially affect the current supply to any locality. Furthermore, the voltage throughout the whole system is more uniform and has fewer and less violent fluctuations, thus assuring a proper voltage supply to the lamps. Multiple street lamps may be connected through a switch to the supply and turned on and off manually, or may be operated as a branch circuit through a pilot wire.

SERIES SYSTEM

In the series circuit which has come into general use in the suburbs of Washington, the line current flows successively through each lamp of the circuit, or, where local current or auto transformers are used, through the primary coils so that the same line current passes through each unit as contrasted to the subdivision of current in the multiple system. The line current must therefore be kept at its rated value. This is done with constant current transformers.

Necessarily if the line current should be broken at any point, all of the lamps on that circuit would be extinguished. This was a great disadvantage in the early series systems and was probably the reason for the popularity of the multiple systems in the early stages. It

became a universal practice to provide a cut out as a shunt across each lamp so that whenever a lamp failure tends to open the current, the voltage impressed upon the insulating film punctures the film. In this manner the lamp is short circuited and electrical supply is maintained for all other lamps of the circuit.

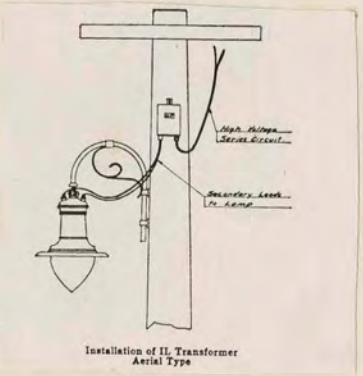


Schematic diagram of a simple series system. Provision must be made so that when a lamp fails, the circuit will maintain its continuity. In the film cutout, the film is punctured due to the high momentary voltage across the filament. In the case of the auto-transformer or the IL transformer, failure of the lamp does not affect the circuit.

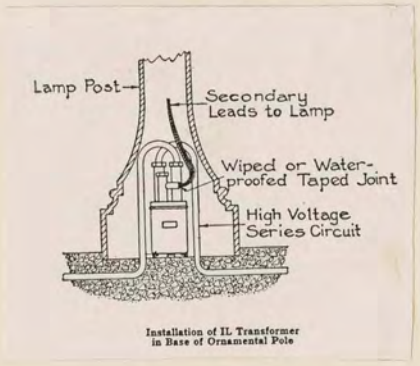
Inasmuch as there is a constant current flowing continuously through a series circuit it is essential that the lamps used be especially built for this purpose. In general these lamps are of the gas-filled type having filaments manufactured to close specifications as regards current capacity. This is in contrast to multiple lamps about which specifications emphasize voltage accuracy. Due to the fact that as the filament vaporizes its diameter decreases, the lamp offers a higher resistance to the current and hence generates more light to offset the blackening effects. Therefore the lamps for direct operation on series circuits give approximately 100% rated initial light throughout life. This

is a considerable advantage of the series system over the multiple system, and was one of the reasons for the series lamps taking the place of multiple lamps in the suburbs of Washington.

Series lamps have been steadily improved in recent years. They now have a nominal life of 1350 hours, and are rated in amperes and lumens. In series street lighting a 6.6 ampere circuit is used very widely. The following size lamps are furnished at this current capacity: 600, 800, 1000, 2500, 4000, and 6000 lumens. If an IL transformer is placed on the line pole it is possible to get the following size lamps: 4000 lumens - 15 amperes, 6000 lumens - 20 amperes, 10,000 lumens - 20 amperes. The transformer serves the double purpose of transforming the current from line amperage to that of the lamp and of providing insulation, the primary and secondary coils being entirely separate. The transformer is mounted right on line pole or in the base of the lamp post as shown in the diagrams.



Installation of IL Transformer
Aerial Type

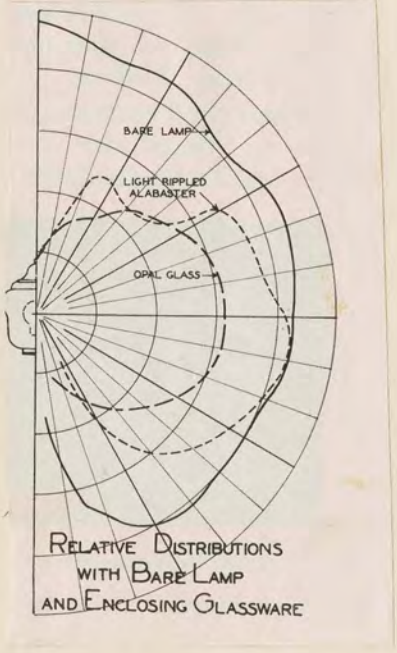


Installation of IL Transformer
in Base of Ornamental Pole

DISTRIBUTION OF LIGHT

Ever since street lights were first introduced in the suburbs there has been development in the distribution of light by street lamps all of which have tended to increase the efficiency of illumination. The distribution of light about a bare lamp depends upon the position of burning and shape of the filament. While it is true that any type of globe surrounding a lamp will reduce the total light output of the unit, it is also true that proper equipment reduces glare, improves appearance and protects the light from the elements. This enclosing glassware was first opal, but the more recent tendency has been toward the rippled type because it presents a more pleasing appearance and gives certain sparkle and animation to the light. The amount of light absorption depends upon the density of the glass and will vary from 10 to 30%.

In the early days it was realized that for the purpose of street lighting, all the light going above the level of the lamp was void. Hence the need of a reflector was realized. One of the earlier types of reflectors which was greatly used throughout the suburbs was the radial



RELATIVE DISTRIBUTIONS WITH BARE LAMP AND ENCLOSING GLASSWARE

wave type reflector. This consisted simply of a metal plate with waves in it and a shiny finish on the surface of the reflector where the light from the lamp struck. The purpose of the waves was to scatter the light over a wider street surface than the flat disc would. The radial wave type after introduced was used in the suburbs to the almost exclusion of other types. The only developments in this type were: the perfection of a porcelain enamel finish on the reflector and improvements in insulation around the socket. Gradually this type is being replaced by either a new reflector type known as the "eternalite" unit or "eternalite globe" lamps in which the reflectors are entirely porcelain.

REFRACTORS

Refractors are combinations of pieces of glassware each molded into a series of prisms which refract the light and redirect it toward the surface of the street. There are two classes of distribution with refractors; namely, symetrical and non-symetrical distribution. The non-symetrical refractors, in addition to redirecting the upward light down, direct most of it on the actual road surface rather than on sidewalks, lawns, etc. This control of the distribution of light has been a great development in street lighting. Two

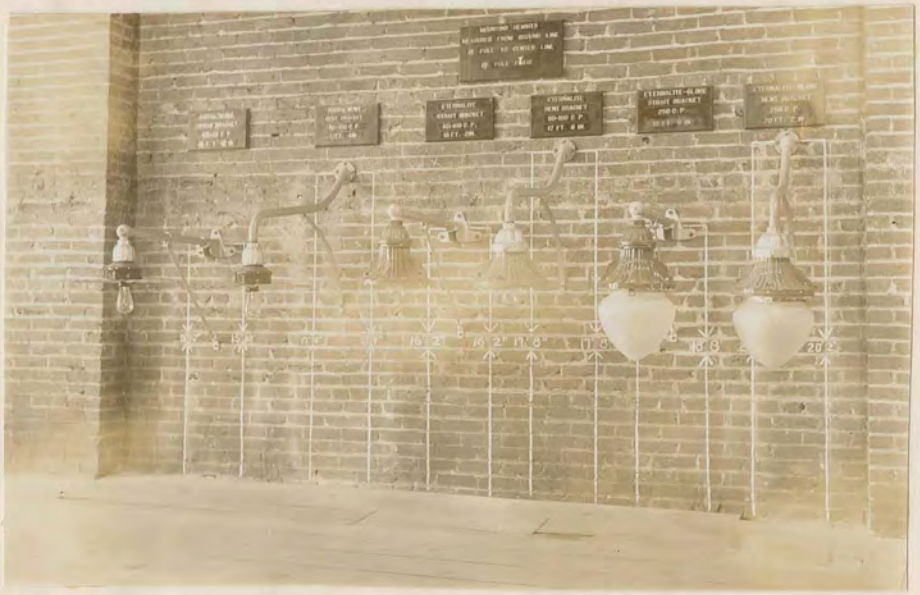
Dome Refractor—Non-symmetrical

types of refractors are the dome and bowl types. The dome type is simpler and is more widely used in the suburbs.

Bowl Refractor—Non-symmetrical

BRACKETS

Brackets are used to hold the fixtures to the line poles and at first were very simple in design. Gradually, in attempt to beautify the fixture, the bracket became more and more ornate. The tendency in recent years, on the other hand, is toward a plain but substantial bracket. At present in the suburbs there are two predominant types - the bent bracket and the straight bracket. Both are shown in the accompanying picture with the mounting heights also given.



Experience has taught us that within certain limits the higher we place the source of light the better the illumination. The spacing of lamps bears a definite relation to the mounting height. The empirical rule accepted by most engineers is that the spacing between lamps must not exceed eight times the mounting height.

PRESENT DAY FIXTURES

At present there are three distinct groups of lighting units in the suburbs. They are as follows: (1) lamp post lighting for the main business street and thoroughfare,

(2) glass enclosed fixtures of the "eternalite globe" type are placed on the line poles on secondary streets adjacent to the main thoroughfare, and sometimes on line poles between street car tracks,



(3) either the radial wave reflector or the eternalite reflector type with the bare lamp are placed on the residential streets of more or less minor importance.


COSTS

The early lighting unit similar to the radial wave reflector type cost $3.90 complete. Now the prices have gone up so that we find that the radial wave reflector unit costs either $9.00 or $9.50 and the lighting units with enclosing glassware cost either $13.00 or $13.50. The

The price depends upon whether the straight or bent bracket type is used - the straight bracket being $.50 cheaper, and of course the lamp post variety is a great deal more expensive. It is evident that street lighting in the suburbs could not reach perfection all of a sudden. The town treasuries have always been too limited for that. It has been the aim, though, to steadily progress toward the fulfillment of ideal requirements and that some day the dream of a perfect lighting system for the suburbs of Washington may become a reality.

B I B L I O G R A P H Y

LIGHTING DATA - BULLETIN LD144A
Edison Lamp Works of G. E. Co.

P. E. P. CO. — Mr. Lockwood - Chief Engineer
Distribution Department - Engineer Division
Mr. Barnes - General Sales Manager

WASHINGTON OFFICE OF GENERAL ELECTRIC CO.

MR. DODD - Town Clerk, Takoma Park.